



Conservation of disturbance-dependent birds in eastern North America

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Abstract Populations of most bird species associated with grassland, shrub-scrub habitats, and disturbed areas in forested habitats (hereafter all referred to as disturbance-dependent species) have declined steeply. However, a widespread perception exists that disturbance-dependent species are merely returning to population levels likely found by the first European explorers and settlers. The fact that many disturbance-dependent bird species and subspecies are now extinct, globally rare, threatened, or endangered challenges that perception and raises the question of balance between conservation efforts for birds dependent upon disturbances and birds more closely associated with mature forests. An overall understanding of the status and trends for these disturbance-dependent species requires reconstruction of at least thousands of years of Native American land use followed by 500 years of post-European settlement. Interpretations herein on how to manage for these disturbance-dependent species should support efforts to conserve all landbirds in eastern North America.

Key Words birds, disturbance, early succession, fire, grasslands, prairies, savanna, shrub-scrub

Most birds associated with open habitats have declined in eastern North America since at least the 1950s, with most eastern states recognizing some of these species on their state protected species lists (Vickery 1992, Ash-ins 2000). These are species associated with a wide variety of natural open habitats including grasslands, prairies, savannas, glades and barrens, hogs. heaven meadows (floodplains),

xeric scrublands, old-growth longleaf pine (*Pinus palustris*) forests, other pine communities, open (old-growth) oak woodlands, and (for some) tree-fall gaps in old-growth forests. Today, many of these species also are associated with active or abandoned farmland (i.e., old fields for the latter), restored coalfields, pastures, clearcuts, utility rights-of-way, roadsides, and (for some)

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group-selection cuts in mature forests.

Species associated with open habitats are often classified as early successional, but many species also occur in mature or old-growth pine (*Pinus* spp.) and oak (*Quercus* spp.) forests where fire and grazing were principal disturbances during pre-European settlement times. Other species depend on trees in open settings such as savannas and open woodlands. Still other species require dense understories such as occur in sizable canopy gaps in mature forests. The common theme in habitat selection of all the above species is that their habitats are maintained by some form of disturbance. Thus, these species can be considered "disturbance-dependent," in contrast to forest-associated species that do not depend on disturbed habitats.

Disturbances in eastern forests take many forms, including fire, storms, grazing mammals (bison [*Bison bison*] and elk [*Cervus elaphus*]), beavers (*Castor canadensis*), forests managed commercially, and lands cleared (at least initially) for farming and development (Lorimer 2001).

Despite the declines underway, some species are still fairly common and widespread as deciphered from any standard bird field guide and from Breeding Bird Survey's relative abundance data (Sauer et al. 2000). Actually, declines during the last 50 years may have occurred after a 100- to 300-year expansion of suitable habitat following European settlement (Hamel and Buckner 1998; Askins 1999, 2000; Litvaitis et al. 1999). The clearing of the forests in eastern North America for European settlement allowed a diversity of successional habitats to coexist. However, the loss of these anthropogenic disturbances, along with decline of natural habitat conditions, now is resulting in significant declines for many species with a trajectory leading toward local extirpations for many species and extinctions for some others as discussed elsewhere (Litvaitis 1993, Litvaitis et al. 1999, Askins 2000).

We first review the species from eastern North America that are now extinct or nearly so, and vulnerable species and subspecies, from federally listed to those that may soon require listing without conservation action. We also describe the status of some representative disturbance-dependent species and review bird communities associated with grassland, shrub-scrub, savannas and open woodlands, and canopy gaps in mature forests. Finally, we discuss the role of "natural" and "anthropogenic" disturbances for conservation and suggest ways to integrate the needs of disturbance-dependent species with mature forest species through consideration of forest structure and landscape context.

Status review of disturbance-dependent or associated species

Species now extinct or nearly so

The extinction of the heath hen (*Tympanuchus cupido cupido*) was an early indication of the plight of disturbance-dependent species that was to come in eastern North America (Table 1). This subspecies of the greater prairie-chicken was common to locally abundant into the early 1800s. This gamebird's dependence on open habitats, particularly grassy oak woodlands and pine barrens, is well documented, but for all practical purposes these communities along the Atlantic seaboard were reduced, fragmented, and, with fire excluded, lost by 1800 (Askins 1999,

Although an increasing number of species require heightened conservation attention, most effective conservation activity should be focused on entire communities.

Litvaitis et al. 1999). The last heath hen died on Martha's Vineyard, Massachusetts, in 1932 or 1933 (Bent 1932).

As with the heath hen, the first naturalists to encounter greater prairie-chickens (*T. c. pinnatus*) in the late 1700s and early 1800s in the Central Hardwoods and Eastern Tallgrass regions reported them as locally common in prairies and barrens (Palmer-Ball 1996). Today most of these populations are extirpated, with very small relict populations persisting elsewhere in the Midwest. A third subspecies, Attwater's prairie-chicken (*T. c. attwateri*), is federally endangered along the coastal prairies of Texas and is extirpated from the coastal prairies of Louisiana.

The extinct passenger pigeon (*Ectopistes migratorius*) and Carolina parakeet (*Conuropsis passerina*) fed on seeds and fruits that occurred most often in open, disturbance-maintained communities (Bent 1932, 1940), though the link between extinction and loss of disturbance-maintained habitats for these species is not as definitive as with the heath hen. The pigeon and parakeet are speculated to have used switchcane "canebrakes" (*Arundinaria gigantea*), a disturbance-maintained community formerly stretching in vast patches along many southern rivers, as roosting and feeding sites (Frost 1995, Platt and Brantley 1997). The Bachman's warbler (*Vermivora bachmanii*) may have foraged and nested primarily in large patches of canebrake, and the loss of this disturbance-maintained habitat may have contributed to this warbler's demise (Remsen 1986, Hamel 1995).

Only the plight of the ivory-billed woodpecker (*Campephilus principalis principalis*) in the southern United States surpasses the interest bird conservationists

Table 1. Extinct and federally listed endangered and threatened disturbance-dependent bird species in eastern North America. Unless otherwise cited, notes on disturbance-maintained communities used by these species are derived from Hamel (1992) and American Ornithologists Union (1998).

Taxon	Legal status	Notes on use of disturbance-maintained communities used
Snail kite Everglades subsp. (<i>Rostrhamus sociabilis plumbeus</i>)	Endangered	Wet prairies and savannas, south-central FL.
Crested caracara Florida population (<i>Caracara cheriway audubonii</i>)	Threatened	Dry prairies and savannas, south-central FL.
Greater prairie-chicken Heath hen (<i>Tympanuchus cupido cupido</i>)	Extinct	Oak savannas, pine-oak barrens; New England–Mid Atlantic..
Greater prairie-chicken Attwater's subsp. (<i>T. c. attwateri</i>)	Endangered	Coastal prairies; central TX, extirpated LA.
Sandhill crane Mississippi subsp. (<i>Grus canadensis pulla</i>)	Endangered	Pine savannas; southern MS.
Whooping crane (<i>Grus americana</i>)	Endangered	Coastal prairies, marshes; south-central TX, extirpated LA, FL?
Eskimo curlew (<i>Numenius borealis</i>)	Endangered	Coastal prairies during northbound migration; LA and TX.
Passenger pigeon (<i>Ectopistes migratorius</i>)	Extinct	Old-growth forests, also fed on seeds and fruits in open country, possibly canebrakes (Platt and Krantley 1997).
Carolina parakeet (<i>Conuropsis carolinensis</i>)	Extinct	Old-growth forests, also fed on seeds and fruits in open country, possibly canebrakes (Platt and Brantley 1997).
Red-cockaded woodpecker (<i>Picoides borealis</i>)	Endangered	Open, mature fire-maintained pine forests throughout South.
Ivory-billed woodpecker United States subspecies (<i>Campephilus principalis principalis</i>)	Endangered-extinct?	Old-growth forested wetlands; probably also old-growth fire-maintained southern pine forests throughout South (Jackson 1996).
Black-capped vireo (<i>Vireo atricapillus</i>)	Endangered	Dense, low fire-maintained thickets and oak shrub-scrub with many openings; central OK, TX.
Florida scrub-jay (<i>Aphelocoma coerulescens</i>)	Threatened	Fire-maintained xeric, low-growing oak scrub with scattered pines; peninsular FL.
Bachman's warbler (<i>Vermivora bachmani</i>)	Endangered-extinct?	Not well known, but likely openings in old-growth forested wetlands, and especially canebrakes; MO and AK east to SC (Remsen 1986, Hamel 1995).
Kirtland's warbler (<i>Dendroica kirtlandii</i>)	Endangered	Shrubscrub, jack pine after stand replacement burns; north-central MI (Botkin et al. 1991, Sykes 1997).
Grasshopper sparrow Florida subsp. (<i>Ammodramus savannarum floridanus</i>)	Endangered	Dry palmetto prairies and savannas; south-central FL.
Seaside sparrow Dusky subsp. (<i>Ammodramus maritimus nigrescens</i>)	Extinct	Wet prairies and savannas; upper St. Johns River, FL.
Cape Sable subsp. (<i>A. m. mirabilis</i>)	Endangered	Wet prairies and savannas; Everglades, south FL.

have for the Bachman's warbler. Ivory-billed woodpeckers require large expanses of old-growth forests for nesting and feeding. However, Jackson (1996) presents a strong case that this species' association with old-growth forests included fire-maintained southern pine communities (longleaf and slash [*P. elliotii* var. *densa*]) throughout Florida and bordering other major floodplains elsewhere. These forests were lost outside of Florida by the early 1800s, while in Florida such forests persisted into the early 1900s.

communities soon after stand-replacement burns on coarse Grayling sands (Sykes 1997). More recently, after many decades of fire suppression, a more modest population size was held stable for many years through a combination of local management and a program to reduce the brown-headed cowbird (*Molothrus ater*). Populations increased only due to larger landscape-level fires during the last decade. Unfortunately, the most appropriate management of Kirtland's warbler habitat is to use large, hot burns. Implementation of large-scale prescribed

Federally listed

A second group of disturbance-dependent species are federally listed as endangered or threatened in all or part of their range (Table 1). Many federally listed species never responded to the flush of habitats created by settlement and today are very rare or still declining. A few federally listed species did experience some historical population stability or expansions, but landscape conditions are changing to the point that continued viability for these species is increasingly in question throughout their ranges.

A prime example of the latter group is the Kirtland's warbler's (*Dendroica kirtlandii*). Its total population size possibly increased during the initial settlement period when logging and slash fires provided a temporary but large increase in suitable nesting conditions (Askins 2000). This species is mostly restricted to the southern edge of the boreal-hardwood transitional forest in Michigan, but north of the regions formerly supporting prairies and savannas (Botkin et al. 1991). The Kirtland's warbler is dependent on jack pine (*Pinus banksiana*) and northern pin oak (*Quercus ellipsoidalis*)



Optimal breeding habitat for Henslow's sparrows at the southern end of their breeding range. Frequent disturbance through prescribed burning and live fire at Fort Campbell Military Reservation, Tennessee-Kentucky, provides and maintains these conditions. The predominant grass is little bluestem (*Andropogon scoparius*), and having scattered weedy patches to a few woody song perches appears to be important for this species as well. Photo by Michael Roedel, The Nature Conservancy.

burning is becoming more difficult as surrounding development and other land-use pressures come into conflict (Kepler et al. 1996). Present population increases now underway for Kirtland's warbler may not be sustained under conditions that are increasingly hostile to conducting effective landscape management.

National Watch List and other vulnerable birds

Many species associated with disturbance-maintained habitats may require elevated conservation attention in the near future. These are National Watch List species, species and subspecies identified by the United States Fish and Wildlife Service as being of conservation concern, or species in need of status review before future federal listing decisions may be made (Carter et al. 1996, 2000, Pashley et al. 2000, United States Fish and Wildlife Service Species of Conservation Concern, unpublished data). Among the highest-priority species and subspecies in need of conservation attention that make use of disturbance-maintained habitats are swallow-tailed kite (*Elanoides forficatus forficatus*), southeastern American kestrel (*Falco sparverius paulus*), Appalachian yellow-bellied sapsucker (*Sphyrapicus varius appalachiensis*), eastern and Appalachian Bewick's wrens (*Thryomanes bewickii bewickii*, *T. b. altus*), golden-winged warbler (*Vermivora chrysoptera*), cerulean warbler (*Dendroica cerulea*), Swainson's warbler (*Limnothlypis swainsonii*), Henslow's sparrow (*Ammodramus henslowii*), and eastern painted bunting (*Passerina ciris ciris*). Henslow's sparrow, golden-winged warbler, and cerulean warbler are the focus of

much conservation interest today, with detailed status assessments either completed or nearly so (Pruitt 1996; Hamel 2000; Buehler et al., unpublished data).

Henslow's sparrow is perhaps the most vulnerable of the nonlisted nongame birds dependent on grasslands in eastern North America. This area-sensitive grassland species is rarely found in patches less than 30 ha (Smith 1992), with preferred patches >100 ha (Herkert et al. 1993, Winter 1999, Winter and Faaborg 1999). Grassland habitats adjacent to hedgerows, treelines, or filter strips are avoided, perhaps because of elevated predator presence (O'Leary and Nyberg 2000, Winter et al. 2000). In addition, Henslow's sparrows prefer grasslands >30 cm tall with residual, standing vegetation from previous growing seasons, which in some areas include the first few years after a clearcut (Pruitt 1996).

Wintering populations of Henslow's sparrow occur primarily in open woodlands, particularly pine flatwoods and savannas, including pitcher plant (*Sarracenia* spp.) bogs. In addition, anthropogenically produced grassy habitats provide important wintering sites, especially in moist sites dominated by broomsedge (*Andropogon virginicus*) grasses (i.e., power rights-of-way, marsh edges, fallow fields). Henslow's sparrows may be most abundant on sites burned during the previous growing season, though birds occur on sites up to 2 years after dormant-season burns (Chandler and Woodrey 1995, Plentovich et al. 1999). However, when an area is being burned during winter, Henslow's sparrows and other wintering grassland birds are displaced from these sites, which may result in reduced overwinter survival (McNair 1998, Plentovich et al. 1998).

Golden-winged warbler is among the most vulnerable species dependent on early successional shrub-scrub habitats. Most golden-winged warbler territories now



Golden-winged warbler nesting location in alder swamp in upstate New York. The proportion of herbs, shrubs, and trees for this territory in a natural wetland looks very similar to the vegetation in many golden-winged warbler territories in human-generated sites undergoing succession. Photo by John Confer, Ithaca College, New York.

occur in secondary succession sites, such as abandoned farmland or clearcuts. In addition, this warbler uses alder bogs, tamarack swamps, and open woodlands with considerable understory. Within this wide range of habitat conditions, all territories provide patches of herbs with moderately dense growth and patches of shrubs or saplings, usually along a boundary with taller trees (Confer 1992, Howe et al. 1996). Historically, this warbler most likely was associated with abandoned beaver (*Castor canadensis*) meadows or other frequently disturbed habitats, including habitats subject to frequent burning (Brewster 1886; Short 1963; Confer unpublished data). Today, this species is associated with anthropogenic disturbances that mimic conditions that were more widespread prior to present-day suppression of fire and beavers. Golden-winged warbler "safe" areas today are concentrated in disturbance sites within boreal-hardwood transitional forests and at the higher elevations of the southern and central Appalachians.

Areas of golden-winged warbler abundance and high nesting success (Confer 1992, Klaus 1999) are generally either north of or at higher elevations than the present strongholds of the blue-winged warbler (*Vermivora pinus*). The golden-winged warbler has disappeared from most of the eastern portion of its range as the blue-winged warbler expanded eastward and northward, perhaps due to hybridization between the two species (Gill 1997). Prolonged coexistence of both species in the Hudson Highlands of southern New York is exceptional, and may be due to habitat segregation gained by golden-winged warblers that nest in locally abundant alder swamps (Confer et al. 1998).

Often golden-winged warbler territories include a forested edge along at least 25% of their territory and breeding birds are successful under a sparse canopied forest (Buehler et al., unpublished data). Potential territories in the middle of a large contiguous area (>40 ha) of abandoned farmland or clearcut lack this forest edge, and therefore few warblers occupy such "interiors" of shrub-scrub habitats (Confer 1992, unpublished data). Logging that leaves residual trees or uncut reserve areas within clearcuts could provide the needed forest edge in similarly large clearcut areas. Treatment areas of 12 to 20 ha, or leaving 10 to 20% residual canopy cover in larger treatment areas, and prescribed burning on a relatively long return interval (7 to 25 years, Frost 1995), could be used to maintain optimal habitat conditions over long periods of time for this species (Huffman 1997, Confer and Canterbury unpublished data).

At the other end of the successional spectrum are cerulean warblers, associated most often with mature hardwood-dominated forests (Robbins et al. 1992).

Cerulean warblers are found to occupy the highest canopy layers for most of the breeding season, but habitat associations are complex and varied depending on landscape characteristics and disturbance histories (Hamel 2000). One feature that is emerging over much of the cerulean warbler's distribution is an affinity for openings adjacent to the largest trees in a stand, often creating a complex canopy structure. In addition to old-growth forests where tree-fall gaps may lead to suitable conditions, cerulean warblers also occupy mature forests adjacent to roadways (e.g., Blue Ridge Parkway in North Carolina and Virginia), areas recently subjected to shelterwood cuts or severe storm damage, and carefully managed private lands (Hamel et al. 1998, Hamel 2000).

Besides those species identified for conservation concern at the national level, other species also have declined precipitously in eastern North America. Some of these are still common and widespread elsewhere in North America and are therefore generally lower-priority species, including upland sandpiper (*Bartramia longicauda*), common ground-dove (*Columbina passerina*), loggerhead shrike (*Lanius ludovicianus*), and vesper sparrow (*Poocetes gramineus*). These species still may be important in local conservation planning efforts, especially when higher-priority species are absent.

Disturbance-dependent bird communities

Although an increasing number of species require heightened conservation attention, most effective conservation activity should be focused on entire communities. Many disturbance-dependent species are not restricted to one habitat type, though many species are associated with grassy conditions, shrub-scrub conditions, savanna and open woodlands, or gaps in mature forests across community types. For eastern North America, we recognize 128 species that are associated with these conditions combined. About 60 other species of forest-associated landbirds are not obviously dependent upon disturbances in eastern North America. Although several of these species are frequently the subjects of forest bird conservation studies, none are considered vulnerable in eastern North America (e.g., barred owl [*Strix varia*], pileated woodpecker [*Dryocopus pileatus*], red-eyed vireo [*Vireo olivaceus*], pine warbler [*Dendroica pinus*], ovenbird [*Seiurus aurocapillus*], and scarlet tanager [*Piranga olivacea*]). In fact, only 2 nondisturbance-dependent forest species are on the Watch List (Bicknell's thrush [*Catharus bicknelli*] and prothonotary warbler [*Protonotaria citrea*]; Pashley et al. 2000). Fully 85% of these 60 species are not declining.

Table 2. Bird species in eastern North America associated with large areas with grass-herbaceous dominated ground conditions (includes prairies, savannas [pine and oak], bogs, glades, and barrens) early after disturbance.

Taxon	Watch list ^a	Continental trend ^b	Notes on disturbance-maintained habitat use ^c
Northern harrier (<i>Circus cyaneus</i>)		-* (BBS)	Grasslands, wet prairies with tallgrass, fields.
Rough-legged hawk (<i>Buteo lagopus</i>)		0 (CBC)	Grasslands, open cultivated areas; winter.
Merlin (<i>Falco columbarius</i>)		0 (CBC)	Open woodlands, grasslands, fields; winter.
Peregrine falcon (<i>Falco peregrinus</i>)		+	Open country usually near water; winter.
Greater prairie-chicken (<i>Tympanuchus cupido pinnatus</i>)	EH	-(BBS)	Tallgrass prairie with some agriculture nearby.
Northern bobwhite (<i>Colinus virginianus</i>)		-* (BBS)	Brushy fields, grasslands, fields, open woodlands.
Sandhill crane (<i>Grus canadensis</i>)		+* (BBS)	Wet pine savanna, wet prairies, adjacent grasslands and fields.
Killdeer (<i>Charadrius vociferus</i>)		-* (BBS)	Wide variety of open habitats, shortgrass, bare ground.
Upland sandpiper (<i>Bartramia longicauda</i>)		(BBS)	Grasslands, especially prairies, dry meadows and pastures with tallgrass, airport margins.
Long-billed curlew (<i>Numenius americanus</i>)	M	-* (USSP)	Wet fields, wet grasslands; Coastal Prairies of TX and LA during winter.
Buff-breasted sandpiper (<i>Tryngites subruficollis</i>)	M	H (USSP)	Dry grasslands with shortgrass, pastures, plowed fields; migration.
Common Snipe (<i>Gallinago gallinago</i>)		+	Wet meadows, wet fields, bogs.
Snowy owl (<i>Nyctea scandiaca</i>)		0 (CBC)	Open country, prairies, fields, pastures, airports; winter.
Burrowing owl Florida subsp. (<i>Athene cunicularia floridana</i>)		(BBS)	Dry Florida prairies, temporarily cleared lands.
Long-eared owl (<i>Asio otus</i>)		-* (CBC)	Roosts in forests, woodlots; forages in fields and meadows.
Short-eared owl (<i>Asio flammeus</i>)	M	-* (CBC)	Open country, prairies, meadows, savanna, with tall grass and moderate density of bare soil.
Common nighthawk (<i>Chordeiles minor</i>)		-* (BBS)	Wide variety of open habitat, especially savanna, grasslands, fields.
Horned lark (<i>Eremophila alpestris</i>)		-* (BBS)	Shortgrass, prairies, grazed pastures, open cultivated areas, bare soil.
Sedge wren (<i>Cistothorus platensis</i>)		+* (BBS)	Grasses, meadows, sedge meadows, wet fields with tallgrass and some bushes.
American pipit (<i>Anthus rubescens</i>)		-* (CBC)	Wet meadows, pastures, cultivated fields; winter.
Sprague's pipit (<i>Anthus spragueii</i>)	MH	-* (BBS)	Shortgrass, prairies, pastures and fields with medium grass; Coastal Prairies in LA and TX during winter.
Bschman's sparrow (<i>Aimophila aestivalis</i>)	EH	-* (BBS)	Open, grassy mature pine woods with scattered bushes, brushy-grassy hillsides, oldfields.
Vesper sparrow (<i>Pooecetes gramineus</i>)		-* (BBS)	Prairie, savanna, oldfields, woodland clearings.
Lark sparrow (<i>Chondestes grammacus</i>)		-* (BBS)	Open situations with scattered bushes and trees, prairie, savanna, cultivated areas.
Savannah sparrow (<i>Passerculus sandwichensis</i>)		-* (BBS)	Grasslands, meadows, bogs, farmlands, pastures.
Crashoppccr sparrow (<i>Ammodramus savannarum</i>)		-* (BBS)	Prairie, old fields, open grasslands, pastures, savanna.
Henslow's sparrow (<i>Ammodramus henslowii</i>)	EH	-* (BBS)	Rank grass interspersed with weeds and shrubs, damp or low-lying areas, breeding; also pine savanna and flatwoods, bogs, with dense grass cover, winter.

(continued)

(See table notes next page)

Grassland and prairie communities

Grassland and prairie communities support species primarily associated with open treeless habitats. Over 99% of the original tall-grass prairie has been lost (Noss et al. 1995). Some prairie species now occur in man-made habitat in once-forested areas of the eastern United States. This only partially compensates for the decline of grassland species as prairies became wheat, corn, soybean, canola, and flax fields. However, some of these species may be found in habitats that may meet the definition of forests, such as sparsely stocked or open pine or oak communities subjected to frequent disturbances favoring grassy ground cover.

The plight of the 3 prairie-chicken subspecies in eastern North America, described above, is testimony to the loss of grasslands, prairies, savannas, and similar habitats. In fact, 8 of the 14 federally listed disturbance-dependent species and subspecies in eastern North America are associated with grassland, prairie, and savanna habitat (Table 1). About 70% of the 37 featured grassland-associated species are undergoing long-term declines or are recently declining in eastern North America (Table 2). Only 5 grassland-associated species appear to be increasing or are stable. For example, sedge wren (*Cistothorus platensis*) and Le Conte's sparrow

Table 2 (continued). Bird species in eastern North America associated with large areas with grass-herbaceous dominated ground conditions (includes prairies, savannas [pine and oak], bogs, glades, and barrens) early after disturbance.

Taxon	Watch list ^a	Continental trend ^b	Notes on disturbance-maintained habitat use ^c
Le Conte's sparrow (<i>Ammodramus leconteii</i>)		+ (BBS)	Moist grass, sedge meadows, tall rank grass, breeding; weedy fields, broomsedge; winter.
Lapland longspur (<i>Calcarius lapponicus</i>)		O (CBC)	Open grasslands, plowed fields, stubble; winter.
Smith's longspur (<i>Calcarius pictus</i>)	E H	O (CBC)	Fields with short grass, prairies, and grassy margins of airports; winter.
Snow bunting (<i>Plectrophenax nivalis</i>)		-* (CBC)	Grassy or weedy fields, stubble; winter.
Dickcissel (<i>Spiza americana</i>)	MH	-* (BBS)	Grasslands, meadows, savannas, cropland (alfalfa), and brushy fields.
Bobolink (<i>Dolichonyx oryzivorus</i>)	M	-* (BBS)	Tall grass, flooded meadows, prairie, cultivated grains and alfalfa.
Red-winged blackbird (<i>Agelaius phoeniceus</i>)		-* (BBS)	Marshes, cultivated fields, breeding; plowed fields, [prairies, pastures, cultivated lands, winter.
Eastern meadowlark (<i>Sturnella magna</i>)		-* (BBS)	Grassland, savanna, open fields, pastures, and cultivated lands.
Brewer's blackbird (<i>Euphagus cyanocephalus</i>)		-* (BBS)	Pastures and fields; winter.
Brown-headed cowbird (<i>Molothrus ater</i>)		-* (BBS)	Feeds primarily cultivated lands, fields, pastures.

^a Watch List species are identified as in need for conservation attention at the national level (EH = extremely high priority, MH = moderately high priority, M = moderate priority; Carter et al. 1996, 2000).

^b Continental population trends for this and subsequent tables are mostly from Breeding Bird Survey (BBS, 1966-1999; <http://www.mbr.nbs.gov/bbs/bbs.html>; Sauer et al. 2000), Christmas Bird Count (CBC, 1959-1988; Butcher 1990), or United States Shorebird Plan (USSP; <http://www.Manomet.org/USSCP.htm>). Population trends are interpreted following Table 4 in Carter et al. (2000) as follows: -* = significant decrease, = = possible decrease, O = trend uncertain, + = stable or possible increase, +* = significant increase.

^c Habitat descriptions as they relate to disturbance-maintained conditions are adapted mostly from AOU (1998) or Hamel (1992). Species breed unless otherwise indicated as primarily migrating or wintering in eastern North America.

(*Ammodramus leconteii*) may benefit during the breeding season from habitat expanding under United States Department of Agriculture Natural Resources Conservation Service's Conservation Reserve Program in the eastern Great Plains (Johnson and Igl 1995, Igl and Johnson 1999, Peterjohn and Sauer 1999). Similarly, these same species make great use during winter of the early stages of afforestation now underway in much of the Southeast through programs such as United States Department of Agriculture's Wetland Reserve Program and similar private land-restoration initiatives (P. Hamel, personal observation).

Grassland patch size appears to be an important factor limiting distribution of many grassland species. Greater prairie-chickens and Henslow's sparrows especially appear to be area-sensitive and occur only in the largest habitat patches. In addition, other species (e.g., dickcissel [*Spiza americana*]) appear to be demographically area-sensitive by consistently occupying small habitat patches but suffering high and generally unsustainable

rates of nest depredation and cowbird parasitism (Winter 1999, Winter and Faaborg 1999). Still other grassland species (e.g., Bachman's sparrow [*Aimophila aestivalis*]) may not easily disperse from one suitable habitat patch to another newly developing patch separated by unsuitable habitats without connecting grassy-dominated corridors (Dunning et al. 1995).

Shrub-scrub communities

Shrub-scrub communities include habitat patches with woody plants that are typically <3 m tall. Natural shrub-scrub communities include Florida's Lake Wales Ridge and coastal scrublands, bog and swamp-shrub communities, and barrens and glades where fire or other disturbances are regular, but with a longer duration between major fire events than

would support more grass-dominated communities. Some shrub-scrub species, notably the golden-winged warbler, occur in dry uplands and wetlands. Both conditions are becoming rare; for example, in pre-colonial New York, beaver-caused floodplains occurred on about 1 million acres (3.5% of New York), although this disturbance habitat is now reduced by 65% (Gotie and Jenks 1982). Species associated with shrub-scrub communities also make great use of old fields, abandoned farmland, restored coalfields, utility rights-of-way, and regenerating clearcuts in the shrub-scrub or seedling-sapling stage of succession.

Three federally listed shrub-scrub-associated species in eastern North America are the Kirtland's warbler in Michigan, black-capped vireo (*Vireo atricapillus*) in Texas and Oklahoma, and Florida scrub-jay (*Aphelocoma coerulescens*) restricted to peninsular Florida (Table 1). About 70% of the 40 featured nonlisted shrub-scrub species are undergoing long-term declines or are recently declining in eastern North America (Table 3). Only 10

Table 3. Bird species in eastern North America associated primarily with large patches (e.g., greater than 5 ha) with shrub-scrub, early successional, and forest edge conditions generally more than 3 years after disturbance.

Taxon	Watch list ^a	Continental trend ^b	Notes on disturbance-maintained habitat use. ^c
Ruffed grouse (<i>Bonasa umbellus</i>)		0 (CBC)	Mixed and deciduous woodlands with openings, oak savannas.
Wild turkey (<i>Meleagris gallopavo</i>)		+* (BBS)	Open woodlands, especially with adjacent or clearings pastures.
American woodcock (<i>Scolopax minor</i>)	M H	-* (USSP)	Moist woodlands, thickets along streams or in boggy areas, usually near wet grassy meadows and fields.
Mourning dove (<i>Zenaida macroura</i>)		-* (BBS)	Savannas, cultivated lands with scattered trees, brushy areas, open woodlands.
Common ground-dove (<i>Columbina passerina</i>)		-* (BBS)	Arid lowland scrub, second-growth scrub, pastures, cultivated lands.
Black-billed cuckoo (<i>Coccyzus erythrophthalmus</i>)		-* (BBS)	Woodland edges, deciduous thickets, shrubby places, and brushy edges of second-growth.
Smooth-billed ani (<i>Crotophaga ani</i>)		-* (Other)	Second-growth scrub; south FL.
Whip-poor-will (<i>Caprimulgus vociferus</i>)		-* (BBS)	Forest and open woodlands, forages over open areas.
Alder flycatcher– Willow flycatcher (<i>Empidonax alnorum</i> – <i>E. traillii</i>)		0 (BBS)	Moist, brushy thickets, open second growth, alder swamps.
Least flycatcher (<i>Empidonax minimus</i>)		-* (BBS)	Open deciduous woodlands, forest edge.
Bell's vireo (<i>Vireo bellii</i>)	EH	-* (BBS)	Dense brush, willow thickets, streamside thickets, scrub oak.
Warbling vireo (<i>Vireo gilvus</i>)		+* (BBS)	Open woodlands often near water.
Philadelphia vireo (<i>Vireo philadelphicus</i>)		+* (BBS)	Open woodland, forest edge, second growth, and alder and willow thickets.
Bewick's wren Eastern subsp., Appalachian subsp. (<i>Thryomanes bewickii bewickii</i> , <i>T. b. altus</i>)		-* (BBS)	Brushy areas, thickets, scrub in open country, brushy edges of woodlands, brush piles.
Veery (<i>Catharus fuscescens</i>)		-* (BBS)	High elevation hardwood and swamp forest, especially areas with shrubby understory, second growth.
Blue-winged warbler (<i>Vermivora pinus</i>)	M	+ (BBS)	Second-growth dominated by shrubs, from old fields to forest edge.
Golden-winged warbler (<i>Vermivora chrysoptera</i>)	EH	-' (BBS)	Tamarack hogs, alder swamps, second-growth, old fields, dominated by shrubs, saplings, and herbaceous growth.
Orange-crowned warbler (<i>Vermivora celata</i>)		0 (CBC)	Variety of wooded habitat edges, especially with dense undergrowth.
Nashville warbler (<i>Vermivora ruficapilla</i>)		+* (BBS)	Open, brushy woodland, second growth, regenerating burns and clearcuts, bogs, brushy riparian.
Yellow warbler (<i>Dendroica petechia</i>)		+ (BBS)	Riparian woodlands, particularly willow, early succession dominated by saplings, regenerating burns and clearcuts.
Chestnut-sided warbler (<i>Dendroica pensylvanica</i>)		-* (BBS)	Early successional woodlands, mountain laurel thickets, forest edge.
Prairie warbler (<i>Dendroica discolor</i>)	M	-* (BBS)	Brushy second growth, dry scrub ridgetops, barrens, mature southern pine, regenerating burns and clearcuts.
Palm warbler (<i>Dendroica palmarum</i>)		-* (CRC)	Open boreal areas with heavy undergrowth and scattered trees, breeding; second-growth, fields, and edges, winter.
Northern waterthrush (<i>Seiurus noveboracensis</i>)		+ (BBS)	Thickets near slow streams, ponds, swamps, bogs.
Connecticut warbler (<i>Oporornis agilis</i>)		-* (BBS)	Spruce and tamarack hogs, locally jack pine barrens.
Mourning warbler (<i>Oporornis philadelphia</i>)		-* (BBS)	Open brushy woodland and second growth, especially regenerating burns and clearcuts.
Common yellowthroat (<i>Geothlypis trichas</i>)		-* (BBS)	Thickets near water, bogs, brushy pastures, oldfields, regenerating clearcuts.
Wilson's warbler (<i>Wilsonia citrina</i>)		-* (BBS)	Riparian thickets of alder and willow, moist undergrowth, dense second-growth and bogs.

(continued)

(See table notes next page)

species are increasing or are stable in eastern North America. One of the increasing species is wild turkey (*Meleagris gallopavo*), benefiting from several decades of intensive and widespread management attention. Among the 6 nongame species undergoing increases, 3 are associated with either burning or logging activities ongoing in boreal hardwood transitional forests and may be disproportionately benefiting from such activity, particularly Nashville warbler (*Vermivora ruficapilla*), compared with co-occurring species undergoing declines (Schulte and Niemi 1998). In the Southeast, only one nongame species is definitely increasing, the blue grosbeak (*Guiraca caerulea*).

Despite some hopeful population trends for a few shrub-scrub species, most are declining steeply. Some of these species also exhibit area-sensitivity. For example, golden-winged warblers mostly avoid small patches (<2 ha) and begin to increase in occupancy and densities at patch sizes >12 ha up to 40 ha (Buehler et al., unpublished data). In addition to golden-winged warbler, other shrub-scrub species may exhibit some form of area-sensitivity, but more work is needed to clarify how large patch sizes need to be first to predict species presence and second for such species to exhibit high levels of reproductive

Table 3 (continued). Bird species in eastern North America associated primarily with large patches (e.g., greater than 5 ha) with shrub-scrub, early successional, and forest edge conditions generally more than 3 years after disturbance.

Taxon	Watch list ^a	Continental trend ^b	Notes on disturbance-maintained habitat use. ^c
Yellow-breasted chat (<i>Icteria virens</i>)	-*	(BBS)	Dense second-growth, riparian thickets, brush, and regenerating clearcuts.
Rufous-crowned sparrow (<i>Aimophila ruficeps</i>)		(BBS)	Brush, scattered scrub or short trees, grassy patches, Ouachitas of Arkansas and Oklahoma.
American tree sparrow (<i>Spizella arborea</i>)	-*	(CBC)	Weedy fields, brush, and hedgerows; winter.
Clay-colored sparrow (<i>Spizella pallida</i>)	-*	(BUS)	Brushy fields, groves, streamside thickets.
Field sparrow (<i>Spizella pusilla</i>)	-*	(BBS)	Old fields, brushy hillsides, overgrown pastures, sparse second growth, hedgerows.
Lincoln's sparrow (<i>Melospiza lincolni</i>)	+	(BBS)	Bogs, wet meadows, riparian thickets, dry brushy clearings.
Swamp sparrow (<i>Melospiza georgiana</i>)	+	(BBS)	Bogs and wet meadows, breeding; weedy fields, brush, thickets, forest edge, shrub-scrub wetlands, winter.
Harris' sparrow (<i>Zonotrichia querula</i>)	MH	-* (CRC)	Thickets, open woodlands, forest edge, windbreaks, hedgerows, scrub; winter.
White-crowned sparrow (<i>Zonotrichia leucophrys</i>)		-* (CBC)	Thickets, farmlands; winter.
Blue grosbeak (<i>Guiraca caerulea</i>)	+	(BBS)	Brushy and weedy fields, young second growth, riparian thickets.
Painted bunting (<i>Passerina ciris</i>)	M H	-* (BBS)	Partly open situations with dense brush and scattered trees, riparian thickets, weedy and shrubby areas.
Orchard oriole (<i>Icterus spurius</i>)		-* (BUS)	Scrub, second growth, brushy hillsides, with scattered trees, open woodlands, orchards.

^a Watch List species are identified as in need for conservation attention at the national level (EH = extremely high priority, MH = moderately high priority, M = moderate priority; Carter et al. 1996, 2000).

^b Continental population trends for this and subsequent tables are mostly from Breeding Bird Survey (BBS, 1966-1999; <http://www.mbr.nbs.gov/bbs/bbs.html>; Sauer et al. 2000), Christmas Bird Count (CBC, 1959-1988; Butcher 1990), or United States Shorebird Plan (USSP; <http://www.Manomet.org/USSCP.htm>). Population trends are interpreted following Table 4 in Carter et al. (2000) as follows: -* = significant decrease, - = possible decrease, 0 = trend uncertain, + = stable or possible increase, +* = significant increase.

^c Habitat descriptions as they relate to disturbance-maintained conditions are adapted mostly from AOU (1998) or Hamel (1992). Species breed unless otherwise indicated as primarily migrating or wintering in eastern North America.

success (Rudnický and Hunter 1993, Burhans and Thompson 1999).

Open woodlands and savanna communities for species requiring trees

Open woodlands are those communities that support mature trees but in densities at which substantial light reaches the ground and disturbances support mostly grass-dominated ground cover. At longer return intervals, some patches of shrub-scrub cover also may be retained in patches of regenerating pine or hardwood. Midwestern savannas (particularly oak-dominated) are stocked sparsely with trees and represent transitional habitats from woodlands to prairies through much of eastern North America. Noss et al. (1995) consider these habitat conditions as critically endangered ones. Species included here are those that require trees but are otherwise associated with open habitats. Many species treated

in grassy and shrub-scrub-dominated habitats also may occur in open woodlands and savannas, but do not require trees.

Red-cockaded woodpecker (*Picoides borealis*) is the best-known federally listed species dependent upon open pine forests (Kulhavy et al. 1995). The red-cockaded woodpecker is a very strict specialist in terms of its cavity requirements, almost always in live pines with red-heart disease. However, many other species require open woodland conditions in eastern North America. Some of these species co-occur with red-cockaded woodpecker, but may require management attention over and above that given to this endangered species (e.g., southeastern American kestrel; Saenz et al. 1998).

About 70% of 21 featured species associated with open woodlands and savannas are undergoing long-term declines or are

declining recently in eastern North America (Table 4). Only 2 species show increasing or stable population trends, with the eastern bluebird (*Sialia sialis*) obviously benefiting from popular nest-box programs throughout eastern North America. The other species possibly increasing is the swallow-tailed kite, but it still numbers only about 5,000 total individuals and remains one of the highest-priority species in need of conservation action in eastern North America (Meyer 1995).

Among widespread and relatively common species associated with savanna or open woodlands are red-headed woodpeckers (*Melanerpes erythrocephalus*), loggerhead shrikes, and brown-headed nuthatches (*Sitta pusilla*), all of which have declined greatly. Despite supposedly ample habitat conditions in rural landscapes (orchards, pine plantations, farmlands with hedgerows, and trees forming shelterbelts), these conditions are inadequate to support many of these species, as evidenced by

Table 4. Bird species associated with disturbance-maintained woodlands, principally native pine and open oak woodland and savanna communities.

Taxon	Watch list ^a	Continental trend ^b	Notes on disturbance-maintained habitat use ^c
Swallow-tailed kite (<i>Elanoides forficatus forficatus</i>)	EH	+ (BBS)	Open pine savannas, feeds over fields, edges adjacent to largely forested areas.
White-tailed kite (<i>Elanus leucurus</i>)		0 (BBS)	Savanna, open woodland, cultivated fields; FL.
Mississippi kite (<i>Ictinia mississippiensis</i>)		0 (BBS)	Open woodlands, prairies near riparian woodlands.
American kestrel (<i>Falco sparverius paulus</i>)		-* (BBS)	Open country with scattered trees, longleaf and other open mature pine forests in South; cavity nester.
Yellow-billed cuckoo (<i>Coccyzus americanus</i>)		-* (BBS)	Open woodland, especially with thick undergrowth, orchards, and streamside groves.
Barn owl (<i>Tyto alba</i>)		(BBS)	Open country, grasslands, cultivated lands; cavity nester.
Chuck-will' + widow (<i>Caprimulgus carolinensis</i>)	M	-* (BBS)	Open pine and oak woodlands, feeds within open forests.
Red-headed woodpecker (<i>Melanerpes erythrocephalus</i>)	M	-* (BBS)	Open woodlands, pine and oak, savannas; cavity nester.
Yellow-bellied sapsucker (<i>Sphyrapicus varius</i>)		+ (BBS)	Deciduous and mixed forests, forest edges near hogs and meadows, regenerating hardwoods; cavity nester.
Northern flicker (<i>Colaptes auratus</i>)		-* (BBS)	Open woodlands, savannas with scattered trees and snags; cavity nester.
Olive-sided flycatcher (<i>Contopus cooperi</i>)		-* (BBS)	Subalpine conifer forests, spruce hogs, burned areas with standing dead trees.
Eastern wood-pewee (<i>Contopus virens</i>)		-* (BBS)	Open woodlands, forest edges.
Eastern kingbird (<i>Tyrannus tyrannus</i>)		-* (BBS)	Open country with scattered trees and shrubs.
Scissor-tailed flycatcher (<i>Tyrannus forficatus</i>)		-* (BBS)	Open country, especially dry grasslands, savanna, scrub, cultivated lands with scattered shrubs and trees.
Loggerhead shrike (<i>Lanius ludovicianus</i>)		-* (BBS)	Open country with scattered trees and shrubs, cultivated land, pastures, savanna.
Brown-headed nuthatch (<i>Sitta pusilla</i>)	MH	-* (BBS)	Open mature pine and pine-oak woodlands; cavity nester.
Eastern bluebird (<i>Sialia sialis</i>)		+* (BBS)	Open woodlands, cultivated areas with scattered trees; cavity nester.
Summer tanager (<i>Piranga rubra</i>)		(BBS)	Open woodlands, including mature southern pine and oak savannas.
Baltimore oriole (<i>Icterus galbula</i>)		-* (BBS)	Open woodlands, forest edge, riparian woodland, orchards.
Common redpoll (<i>Carduelis flammea</i>)		0 (CBC)	Open woodlands, weedy fields, fencerows; winter.
American goldfinch (<i>Carduelis tristis</i>)		- (BBS)	Open woodlands, forest edge, second growth, orchards, weedy fields, cultivated lands.

^a Watch List species are identified as in need for conservation attention at the national level (EH = extremely high priority, MH = moderately high priority, M = moderate priority; Carter et al. 1996, 2000).

^b Continental population trends for this and subsequent tables are mostly from Breeding Bird Survey (BBS, 1966-1999; <http://www.mbr.nbs.gov/bbs/bbs.html>; Sauer et al. 2000), Christmas Bird Count (CBC, 1959-1988; Butcher 1990), or United States Shorebird Plan (USSP; <http://www.Manomet.org/USSCP.htm>). Population trends are interpreted following Table 4 in Carter et al. (2000) as follows: -* = significant decrease, = possible decrease, 0 = trend uncertain, + = stable or possible increase, +* = significant increase.

^c Habitat descriptions as they relate to disturbance-maintained conditions are adapted mostly from AOU (1998) or Hamel (1992). Species breed unless otherwise indicated as primarily migrating or wintering in eastern North America.

continued declines (e.g., Pruitt 2000).

Forest openings in hardwood or mixed forest communities

Forest openings are habitats developing after disturbances that may occur from tree-fall gaps in old-growth

forests or from other disturbances, natural and anthropogenic. We include species here that inhabit these openings or the edges around openings, but are otherwise characterized as forest-associated species.

No federally listed species depends on forest openings as defined here. Over 45% of the 30 species featured are undergoing long-term declines or are recently declining in eastern North America (Table 5). Twelve species have stable or increasing trends, 5 of which may be benefiting from ongoing timber harvests in boreal-hardwood transitional forests. However, other co-occurring species are undergoing declines in these same forests, such as bay-breasted warbler (*Dendroica castanea*), Canada warbler (*Wilsonia canadensis*), and white-throated sparrow (*Zonotrichia albicollis*).

The proportion of declining species within this group of featured species is low compared with other groups. This highlights a possible difference in the relative threat between species associated with smaller disturbances in mature forests and the previous 3 groups of species dependent on larger-scale and more frequent disturbances. Still, the number of declining species associated with openings in mature forests is double that for increasing

species. The declines documented for species dependent on openings (less than 4 ha) within mature forests does suggest that some managed disturbance may be warranted, or compatible at least, to support mature forest-associated species (Kilgo et al. 1996, Morse and Robinson 1998).

Table 5. Bird species associated with disturbances within forests, especially small (<4 ha) but also for some species larger patches.

Taxon	Watch list ^a	Continental trend ^b	Notes on disturbance-maintained habitat use ^c
Spruce grouse (<i>Falci pennis canadensis</i>)		+* (CBC)	Spruce and other conifer forests, with dense cover of grasses and shrubs as in burned areas.
Three-toed woodpecker (<i>Picoides tridactylus</i>)		() (BBS)	Spruce and other conifers, favoring areas with many large dead trees, such as burns and insect outbreaks.
Black-backed woodpecker (<i>Picoides arcticus</i>)		0 (BBS)	Spruce and fir forests, especially windfalls and burned areas with standing dead trees.
White-eyed vireo (<i>Vireo griseus</i>)		+ (BBS)	Dense undergrowth at deciduous forest edge and treefalls.
Blue-gray gnatcatcher (<i>Poliophtila caerulea</i>)		+* (BBS)	Deciduous forests, pine-oak woodlands breeding; in winter dense second-growth, dense.
Swainson's thrush (<i>Catharus tridactylus</i>)		(BBS)	Dense scrub, coniferous (spruce) woodland with dense undergrowth, second growth, thickets.
Hermil thrush (<i>Catharus guttatus</i>)		+* (BBS)	Open coniferous and mixed forest, sparse jack-pine.
Wood thrush (<i>Hylocichla mustelina</i>)	MH	-* (BBS)	Deciduous forest and woodland, locally dense second-growth with dense shrub layer,
Gray catbird (<i>Dumetella carolinensis</i>)		+ (BBS)	Thickets, dense brushy areas, undergrowth along forest edge.
Brown thrasher (<i>Toxostoma rufum</i>)		-* (BBS)	Thickets and brushy areas in forest clearings and forest edge, shrubby areas,
Tennessee warbler (<i>Vermivora peregrina</i>)		0 (BBS)	Open woodlands with brushy undergrowth and herbaceous ground cover.
Magnolia warbler (<i>Dendroica magnolia</i>)		+* (BBS)	Open moist spruce-fir or mixed forest, forest edge, second-growth.
Cape May warbler (<i>Dendroica tigrina</i>)		0 (BBS)	Spruce forest usually open, spruce bogs.
Black-throated blue warbler (<i>Dendroica caerulescens</i>)	MH	+ (BBS)	Deciduous or mixed woodland and second growth with dense understory.
Bay-breasted warbler (<i>Dendroica castanea</i>)	M	(BBS)	Boreal forest with openings, occasionally second growth and deciduous scrub.
Cerulean warbler (<i>Dendroica cerulea</i>)	EH	-* (BBS)	Mature deciduous forests, usually tall trees present, complex canopies often near canopy gaps.
Black-and-white warbler (<i>Mniotilta varia</i>)		+ (BBS)	Mature forests, tall trees present, dense understory.
American redstart (<i>Setophaga ruticilla</i>)		+ (BBS)	Open woodlands, riparian (cottonwood and willow), and second growth.
Worm-eating warbler (<i>Helminthos vermivorus</i>)	MH	+ (BBS)	Deciduous forest and damp, brushy ravines with dense undergrowth, regenerating clearcuts.
Swainson's warbler (<i>Limnithlypis swainsonii</i>)	EH	+* (BBS)	Forested wetlands with dense undergrowth and sparse ground cover; dense second growth and canebrakes; also rhododendron thickets in mountains.
Kentucky warbler (<i>Oporornis formosus</i>)	M	-* (BBS)	Deciduous forest with dense herbaceous undergrowth, dense second growth, shady ravines, swamp edges.
Hooded warbler (<i>Wilsonia citrina</i>)		+ (BBS)	Deciduous and mixed forest with dense understory near streams, ravines, second growth.
Canada warbler (<i>Wilsonia canadensis</i>)		-* (BBS)	Moist woodland with dense undergrowth, bogs and tall scrub along streams.
Eastern towhee (<i>Pipilo erythrophthalmus</i>)		-* (BBS)	Dense second growth, undergrowth of open woodland, forest edge.
Fox sparrow (<i>Passerella iliaca</i>)		+ (BBS)	Undergrowth of forests, forest edge, woodland thickets, breeding; variety of habitats with thickets.
White-throated sparrow (<i>Zonotrichia albicollis</i>)		-* (BBS)	Forests, forest edge with dense understory, clearings and bogs.
Dark-eyed junco (<i>Junco hyemalis</i>)		--- (BBS)	Forests, forest edge, clearings, bogs, brushy areas, open woodlands.
Rose-breasted grosbeak (<i>Pheucticus ludovicianus</i>)		-* (BBS)	Open forest, forest edge, woodland, tall second growth

(continued)

(See table notes next page)

Managing mature forest and disturbance-dependent species in the same landscapes

Many disturbance-maintained ecosystems have been lost from the eastern North American landscape during the last 300 years. The only evidence of their former extent is etched in the memoirs of the first European explorers, naturalists, and settlers. Robbins (1996) describes the pre-settlement Maryland landscape as likely rich in diversity of relatively stable early successional habitats in large patches, otherwise embedded within mature and old-growth forests. While there is a common misconception that many disturbance-dependent species moved into the East from the West, or into the Northeast from the Southeast, Robbins (1996: 20) suggests otherwise:

"It is more likely, however, that most of these purported immigrants were native to the natural openings in the presettlement landscape. The upland sandpiper, northern harrier [*Circus cyaneus*], loggerhead shrike, savannah sparrow [*Passerculus sandwichensis*], lark sparrow [*Chondestes grammacus*], Henslow's sparrow, and Bachman's sparrow probably shifted their nesting requirements to man-made fields after Europeans usurped the natural openings. . . ."

Table 5 (continued). Bird species associated with disturbances within forests, especially small (<4 ha) but also for some species larger patches.

Taxon	Watch List ^a	Continental trend ^b	Notes on disturbance-maintained habitat use ^c
Indigo hunting (<i>Passerina cyanea</i>)		..* (BBS)	Deciduous forest edge, regenerating sites, open woodlands, second growth, shrubby areas.
Rusty blackbird (<i>Euphagus carolinus</i>)		..* (CBC)	Moist woodlands, bushy hogs, wooded edges of water bodies, breeding: forested wetlands, open woodlands, pastures, winter.

^a Watch List species are identified as in need for conservation attention at the national level (EI-I = extremely high priority, MH = moderately high priority, M = moderate priority; Carter et al. 1996, 2000).

^b Continental population trends for this and subsequent tables are mostly from Breeding Bird Survey (BBS, 1966-1999; <http://www.mbr.nbs.gov/bbs/bbs.html>; Sauer et al. 2000), Christmas Bird Count (CBC, 1959-1988; Butcher 1990), or United States Shorebird Plan (USSP; <http://www.Manomet.org/USSCP.htm>). Population trends are interpreted following Table 4 in Carter et al. (2000) as follows: -* = significant decrease, . = possible decrease, O = trend uncertain, + = stable or possible increase, +* = significant increase.

^c Habitat descriptions as they relate to disturbance-maintained conditions are adapted mostly from AOU (1998) or Hamel (1992). Species breed unless otherwise indicated as primarily migrating or wintering in eastern North America.

Allowing "nature to take its course" cannot restore the disturbance-maintained ecosystems present prior to European settlement. These conditions are likely lost forever due to the permanent loss of land to human development, loss of keystone species, disruption of natural processes, and an ever-increasing array of exotics (Askins 2000). Nevertheless, we need to understand disturbance-maintained communities and the species dependent upon them so that management strategies can be as effective as the existing science allows.

The key forest bird management issue today lies in how best to protect, create, or restore an appropriate mix of frequently disturbed and infrequently disturbed forested conditions. Given that natural disturbance factors no longer function as they once did, more direct management intervention may be justified from an ecological restoration point of view (Askins 2000). However, restoration should not be at the expense of developing future old-growth conditions in many areas where mid-successional stands now dominate.

Many eastern North American forests today are relatively young (<100 years, Byrd 1996, Trani et al. 2001), such that natural tree mortality resulting in natural forest openings and a long-term series of autogenic regeneration events are almost non-existent. Certainly old-growth conditions for forests not subject to frequent disturbances from storm damage, fire, or grazing are underrepresented compared with pre-European settlement times. Areas dominated by old-growth forest occurred in the expansive forested wetlands of the Southeastern Coastal Plain (including here the Mississippi Alluvial Plain and Peninsular Florida) and in the more sheltered coves of the Appalachians where fire and other disturbance factors

were likely rare (Byrd 1996, Delcourt and Delcourt 1997). In time, most likely measured in terms of several centuries, we might expect a return of autogenic regeneration through a return of tree-fall dynamics that should improve the status of most gap-associated species in presently preserved forests (wilderness areas, national parks, etc.).

As an alternative, silvicultural approaches could be used to remedy the present shortage of structural diversity in today's even-aged forests (e.g., Powell et al.

2000, Thompson and DeGraaf 2001). Available data indicate that even-aged silviculture, with at least 100-year rotations in largely forested areas, appears to have little effect on relative abundance of most vulnerable mature forest species, though it provides for greater numbers of early successional species. For example, Thompson et al. (1992) found that some mature forest species occurred in greater numbers in landscapes managed by even-aged silviculture than in passively managed wilderness areas (but not yet supporting old-growth conditions).

Thompson (1993) and Annand and Thompson (1997) suggest that in largely forested regions, a combination of uneven-aged and even-aged management may provide stability for mature forest and early successional species.

Evidence is accumulating that early successional habitats also are important for species typically considered to be associated with mature forests (Pagen et al. 2000). For example, fledgling wood thrushes (*Hylocichla mustelina*) move substantial distances (up to 6 km) to seek out patches of disturbance-associated habitats, which may prove critical for providing abundant food resources and protective cover from predators when compared with natal sites dominated in eastern North America today by mid-successional forest conditions (Anders et al. 1998, Vega Rivera et al. 1998). Similar results were found for molting adult wood thrushes in terms of their seeking out "safe havens" where understory cover was denser than around nesting sites (Vega Rivera et al. 1999, Powell et al. 2000). Studies on land-bird migration also are demonstrating the importance of larger forest openings to support abundant food resources and protective cover (Kilgo et al. 1999, Suthers et al. 2000).



Cerulean warbler habitat along an old strip-mined contour bench bordering mature mixed deciduous forest in southern West Virginia. Photo by Ronald Canterbury, Concord College, West Virginia.

Proposals to increase managed disturbance also must be integrated with efforts to minimize forest fragmentation effects, including increased depredation and cowbird-parasitism rates, invasions by exotic species, and disruption of natural disturbance processes (especially fire and hydrology). One approach to providing early successional conditions and minimizing fragmentation effects is repeated disturbance to the same stands, therefore minimizing the need to cut other stands as frequently as would be done during a strictly commercial operation (e.g., Litvaitis and Villafuerte 1996). Clearcuts, for example, are most suitable for Henslow's sparrows for 1 to 2 years after harvest and for golden-winged warblers for about 10 years at most (Pruitt 1996, Klaus 1999). Clearcuts followed by one-time management to suppress woody growth might extend the duration of the shrubland condition and thus support an abundance of shrubland birds for 30 years instead of 10 years. Prescribed fire or herbicide treatments may arrest succession and maintain quality grass and shrub communities over longer periods of time than that evident in managed landscapes where such practices are avoided (Schulte and Nicmi 1998; Confer, unpublished data).

Negative effects from forest fragmentation (Robbins 1980, Blake and Karr 1987, Robinson et al. 1995) led to defining many Nearctic-Neotropical migrants as "area-sensitive," "forest-interior" dependent, or both. However, area-sensitive and forest-interior are complex, species-specific designations based on habitat relationships that differ depending on the percent of the landscape forested, as well as other site-specific factors. Area-sensitivity also applies to disturbance-dependent species as discussed here (Annand and Thompson 1997). A review by Vi Iland (1998) and meta-analysis by Hartley and Hunter (1998) also suggest that, with respect to for-

est species, these terms are applied too generally without regard to landscape context (also see Robinson et al. 1995, Donovan et al. 1997).

Largely forested regions, such as the "northern" woods of the Northeast and upper Midwest United States and eastern Canada, the Southern Blue Ridge and Cumberland Plateau of the Appalachians, and the Ozark-Ouachita Highlands, are important for supporting mature forest and disturbance-dependent species. Management decisions may not require close inspection of fragmentation effects as long as forest cover exceeds 70% of the land base, with respect to agriculture and development (Robinson et al. 1995). In more fragmented regions, such as southern New England, the Ridge and Valley within the Appalachians, Shawnee Hills within the Central Hardwoods region, and the Mississippi Alluvial Plain, greater attention must be given to forest patch size. In these areas, segregation of mature forest-dominated habitats is likely necessary from patches that are intended to target grassland and shrub-scrub species (Herkert et al. 1993, 1996; Robinson 1996).

Conclusion

The period of abrupt change from naturally (and culturally) based disturbances to those associated with European and African settlement reached an apex around 1800 along most of the Atlantic Seaboard and Northeast, while they were just beginning in the Appalachians and points westward (Buckner and Turrill 1999). Expansive savannas and prairies described during the 1700s were all but gone by the early 1800s (Noss et al. 1995). After extensive and destructive forest clearing and burning



During winter, high numbers of Henslow's sparrows hide under very dense cover of savanna grasses and forbs at Mississippi Sandhill Crane National Wildlife Refuge, Mississippi. Photo by William Howe, United States Fish and Wildlife Service.

practices in the 1800s, fire suppression policies followed almost unchallenged from the 1930s until the late 1980s. As a result, most disturbance-dependent birds have undergone a cycle of population increases followed most recently (and into the foreseeable future) by decreases in population trends.

Almost all disturbance-dependent birds, regardless of present status, would benefit from returning fire to many of the ecosystems of eastern North America. However, in many areas some level of thinning or mechanical removal of midstory and canopy vegetation may be necessary before fire is reintroduced. In other areas, the details still need to be developed for most effectively implementing fire management for conservation purposes. The role of silvicultural- and grazing-based disturbances also must be considered independent of the use of fire as use of prescribed burning becomes increasingly unpopular or cost-prohibitive in many areas.

Many disturbance-dependent species may in the near future require greater levels of legally based conservation action, such as federal listing, without aggressive restoration of disturbance-maintained communities. Much needs to be learned regarding the most appropriate and responsible approaches to improving forest habitat condition through silviculture and prescribed burning. The future challenge is to conduct necessary management for disturbance-dependent species in eastern North America while balancing the needs of other species of conservation interest associated with older forests not subject to frequent disturbances (see Thompson and DeGraaf 2001).

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